Investigation of Layered Sediments and Clays at a Proposed Landing Site in Ladon Valles

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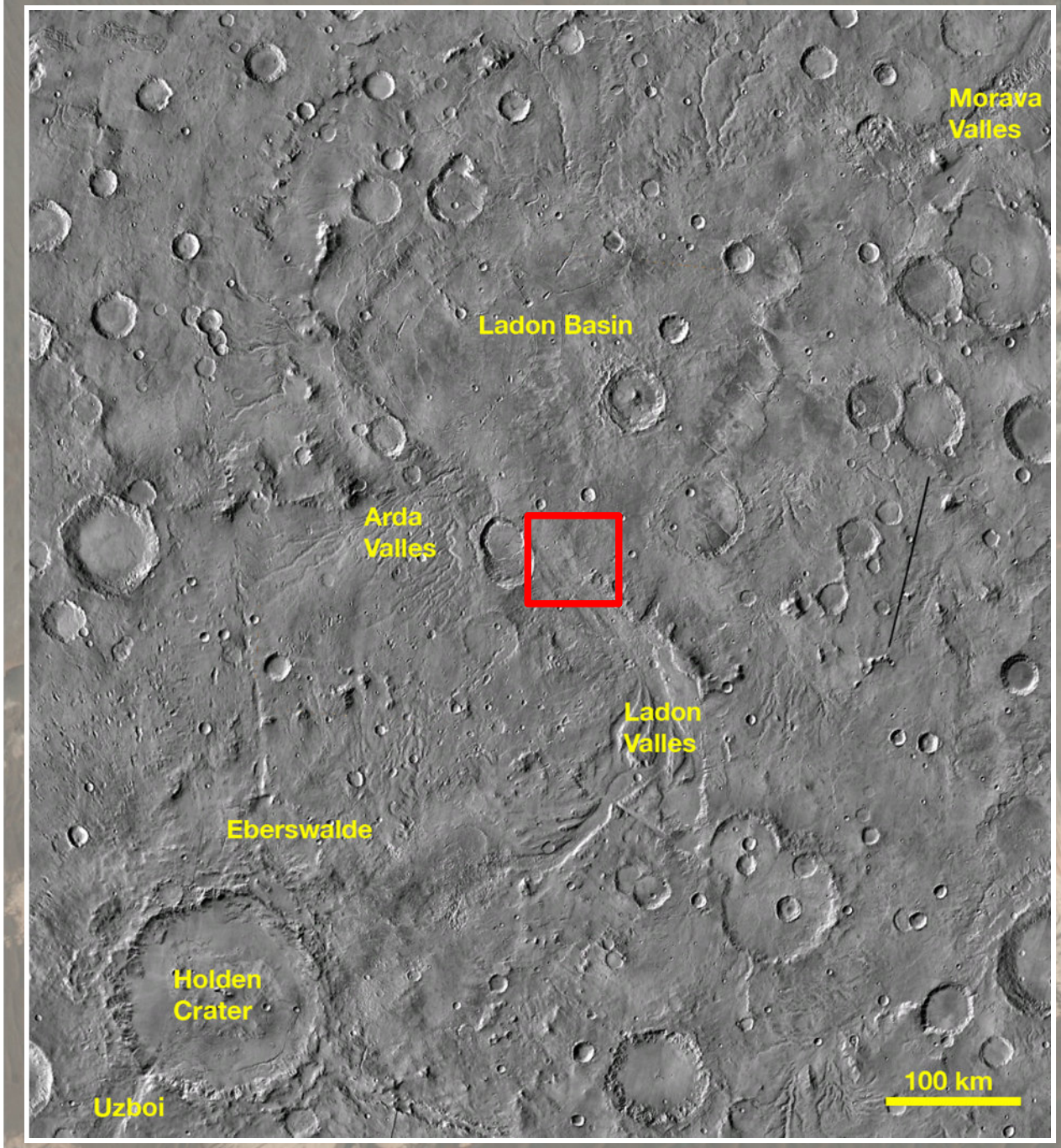
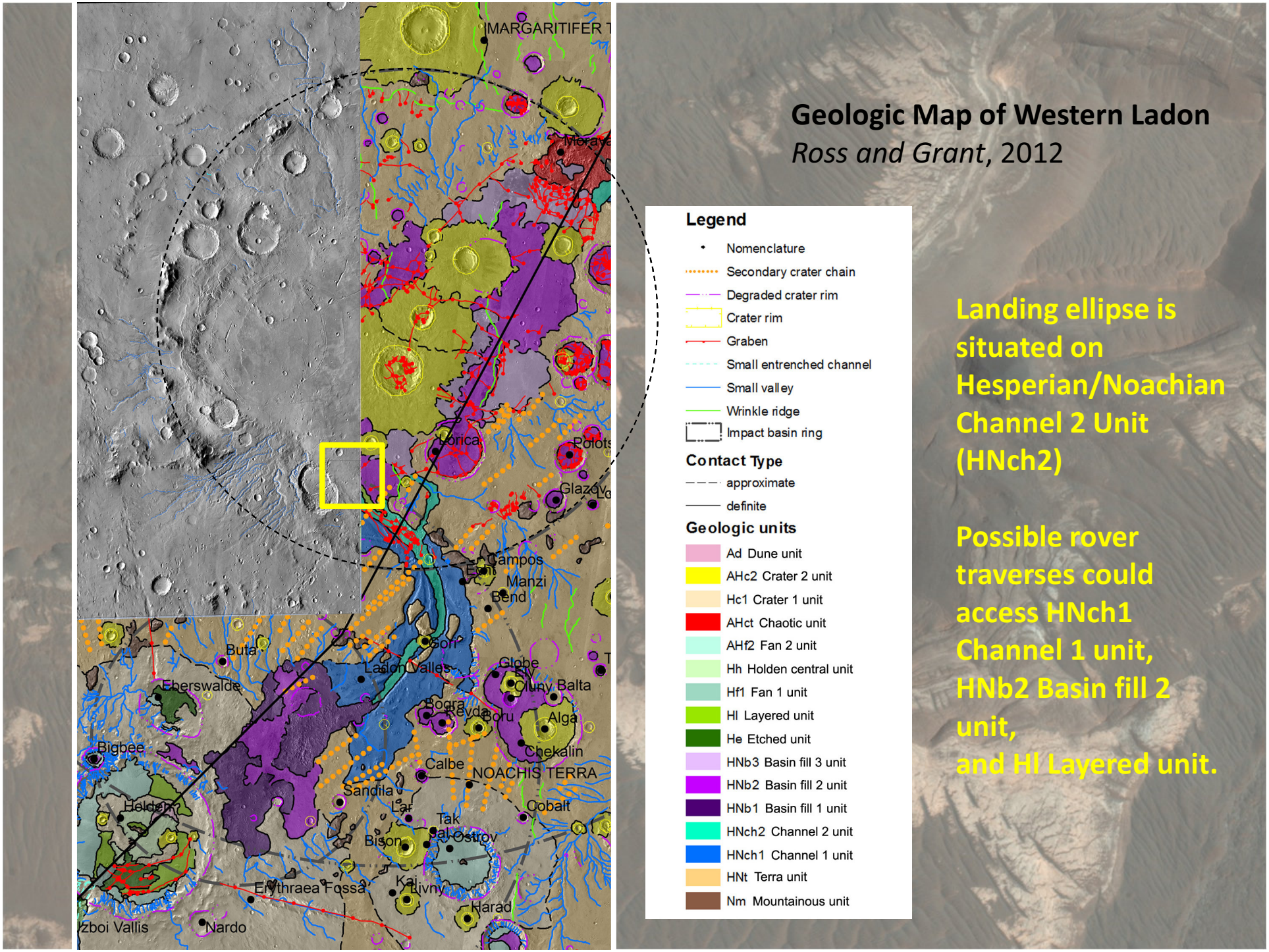


We propose a landing site at the distal end of Ladon Valles.

Ladon Valles is the middle segment in the Uzboi-Ladon-Morava system that formed in the Noachian/Hesperian.

The prime science targets include layered sediments of possible fluvial/lacustrine origin seen in HiRISE images, and clays identified in CRISM data.

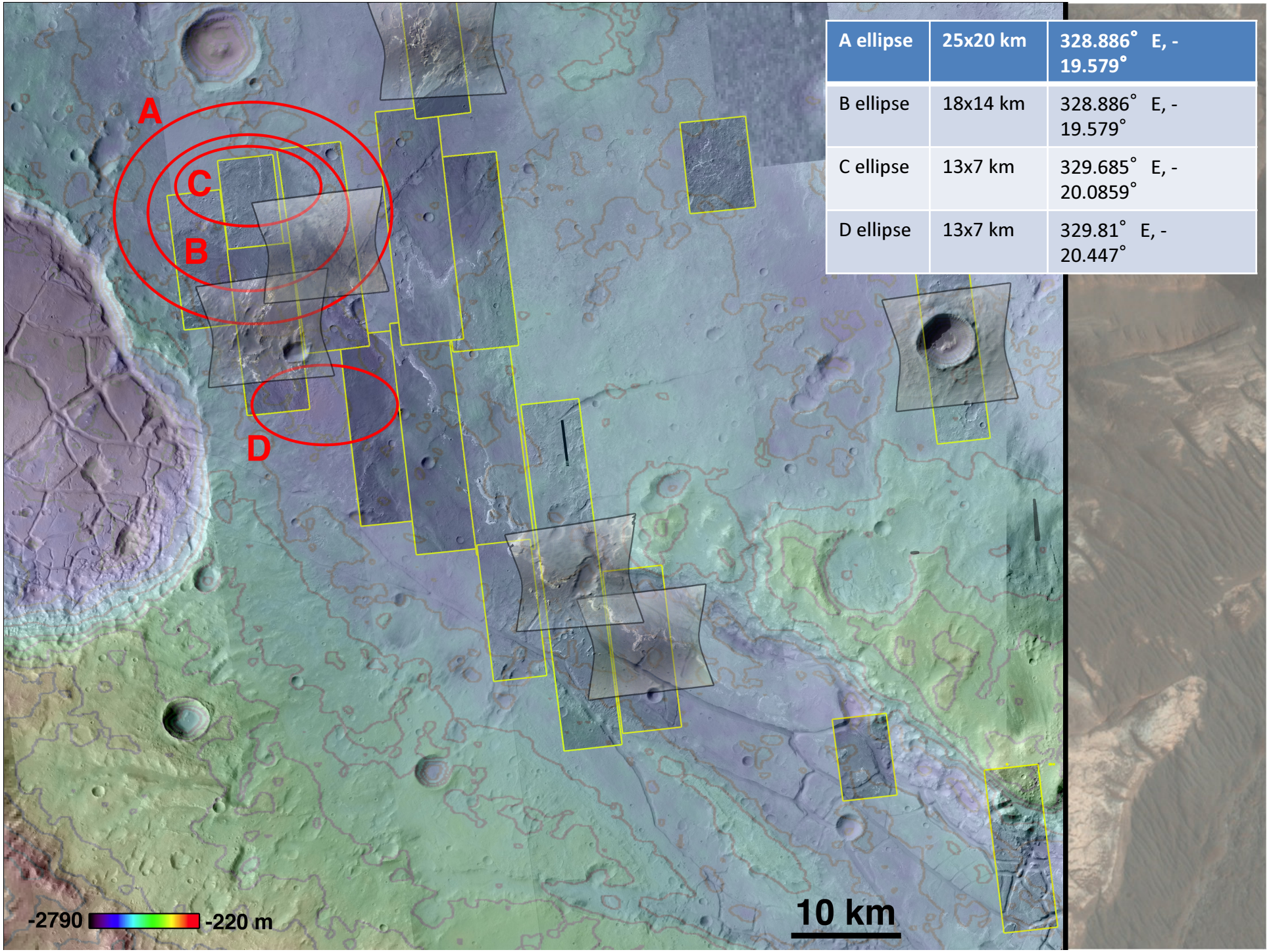


Geologic Map of Western Ladon

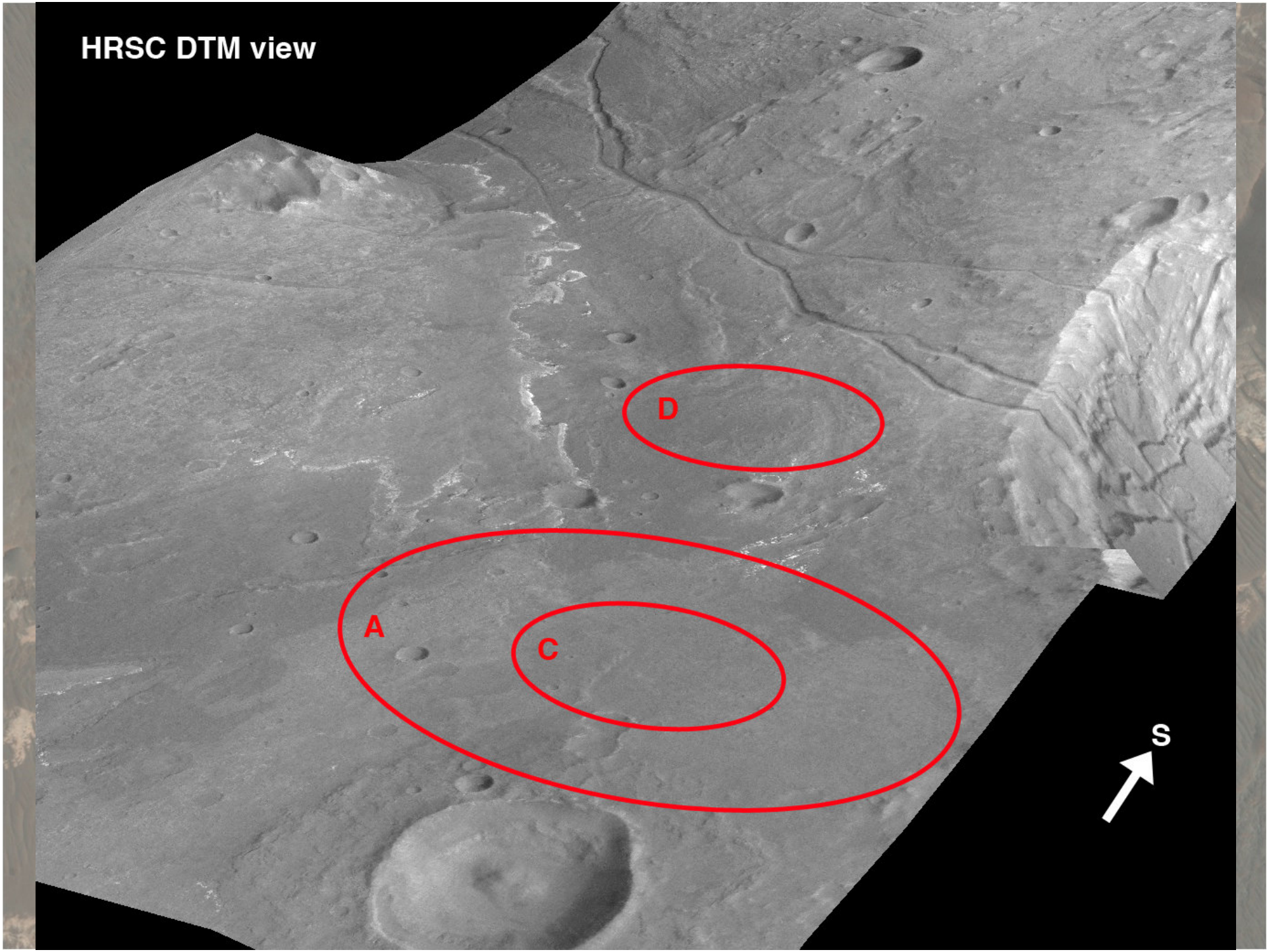
Ross and Grant, 2012

Landing ellipse is situated on Hesperian/Noachian Channel 2 Unit (HNch2)

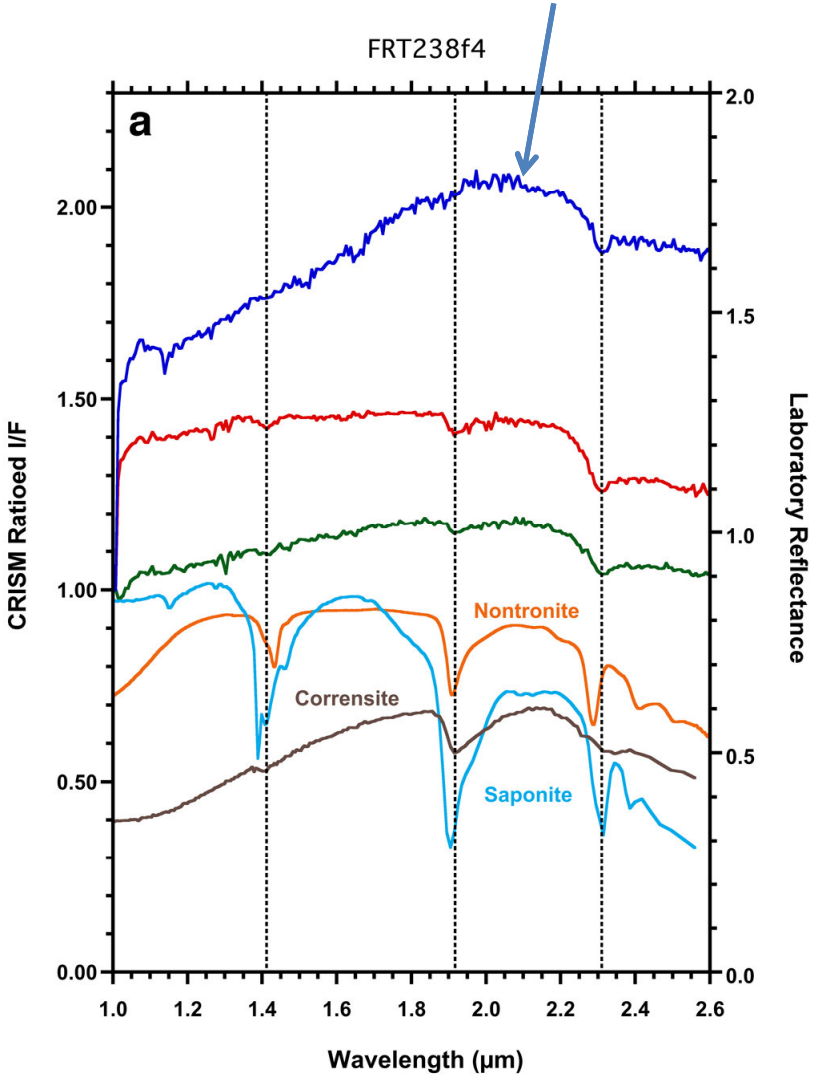
Possible rover traverses could access HNch1 Channel 1 unit, HNb2 Basin fill 2 unit, and Hl Layered unit.

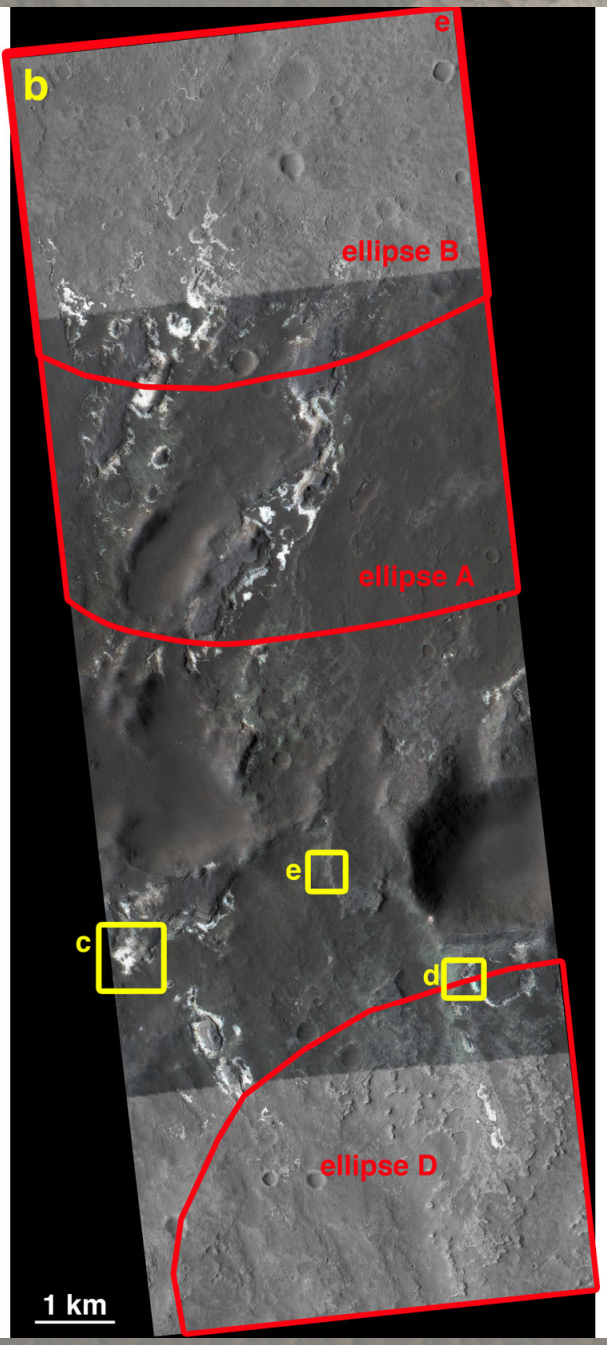


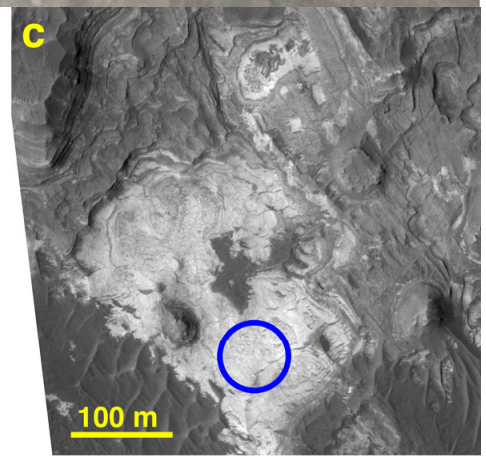
A ellipse	25x20 km	328.886° E, -19.579°
B ellipse	18x14 km	328.886° E, -19.579°
C ellipse	13x7 km	329.685° E, -20.0859°
D ellipse	13x7 km	329.81° E, -20.447°

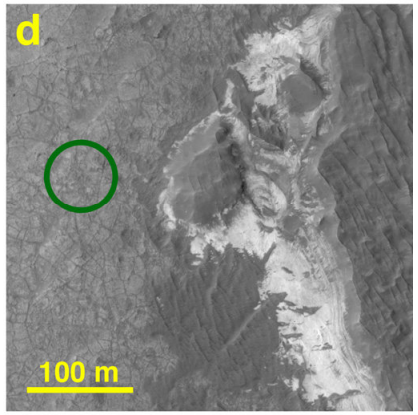

HRSC DTM view
D
A
C
S

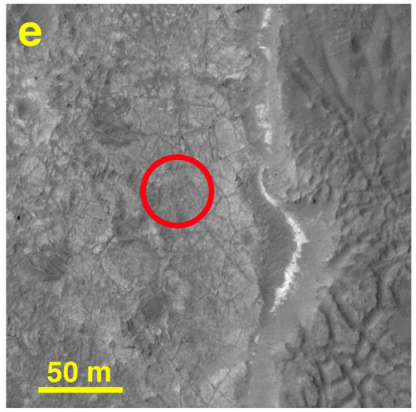
Heated smectites lose H_20 bands [Morris et al., LPSC Abstract 2156, 2010]



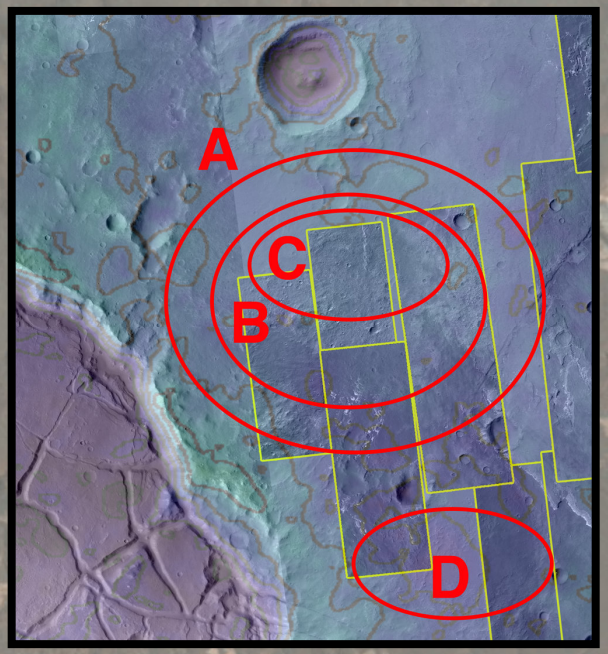


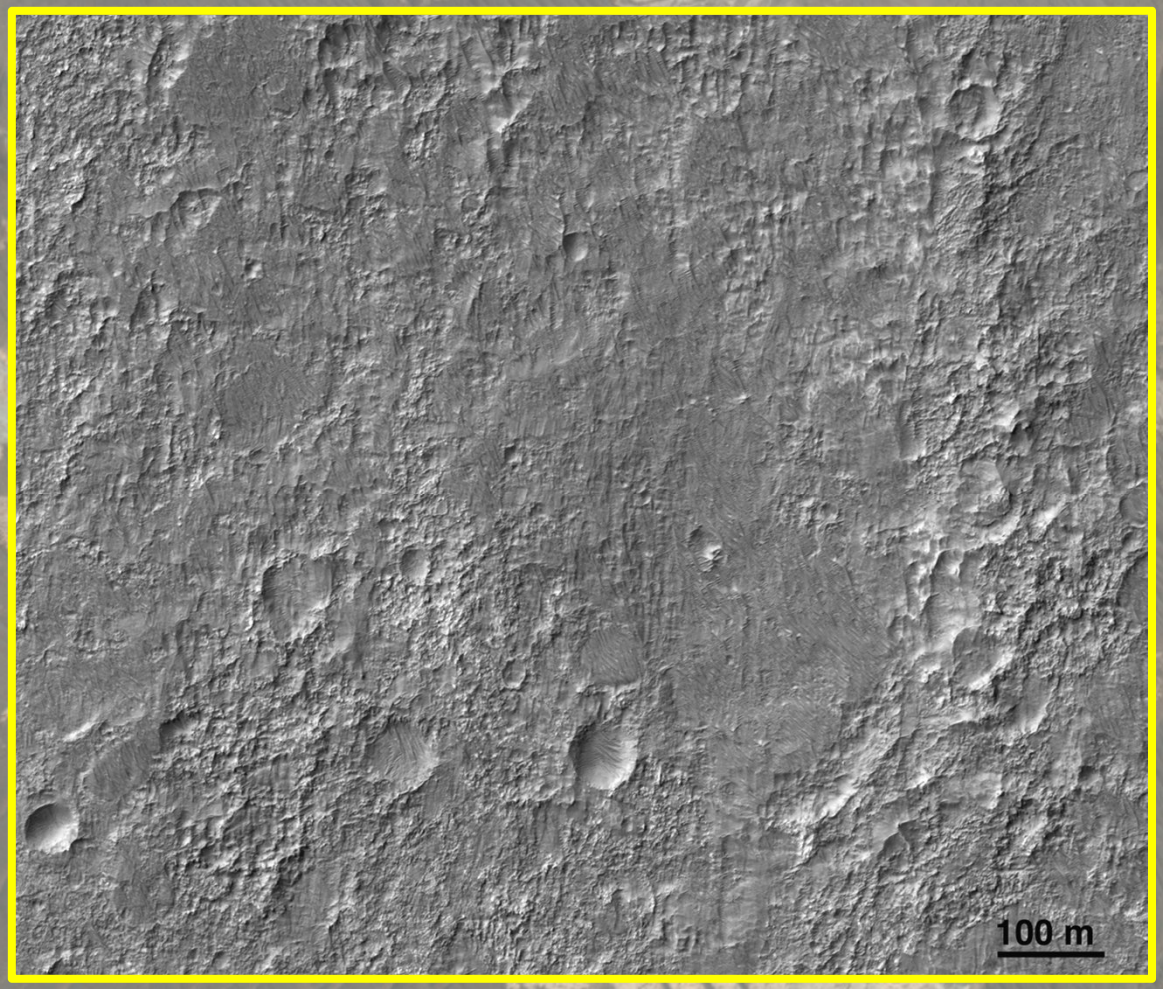


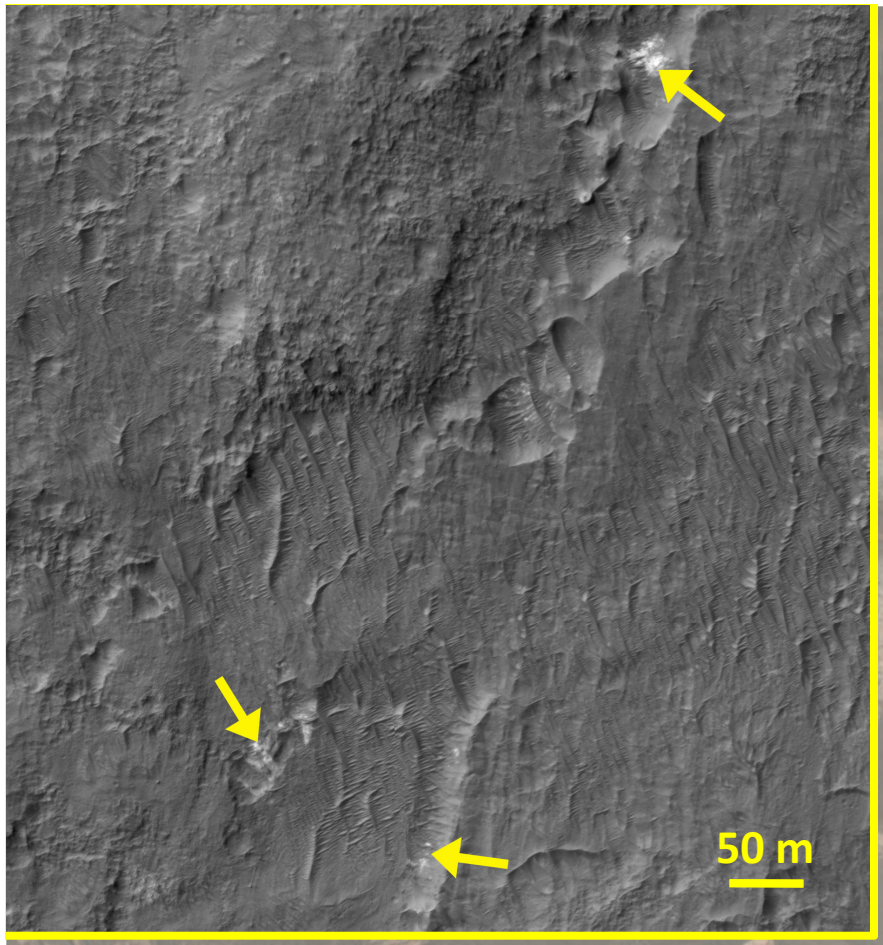




Example of terrain in center of ellipse C

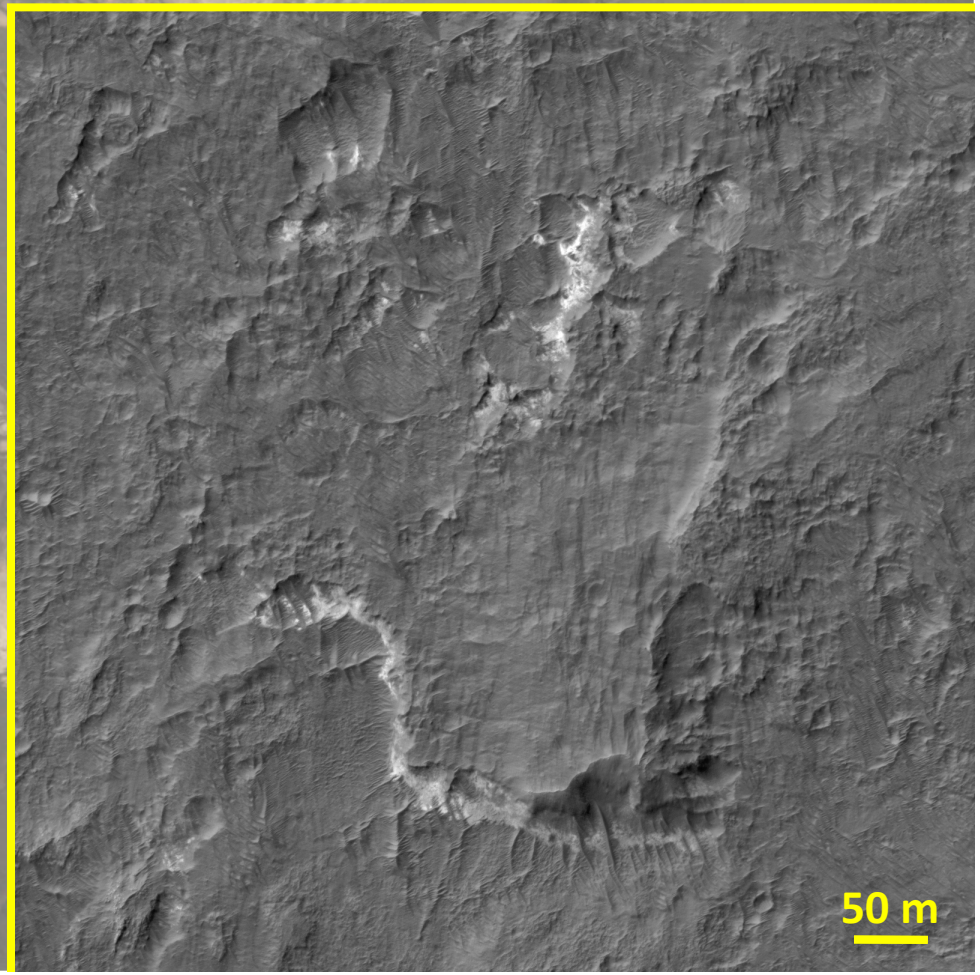






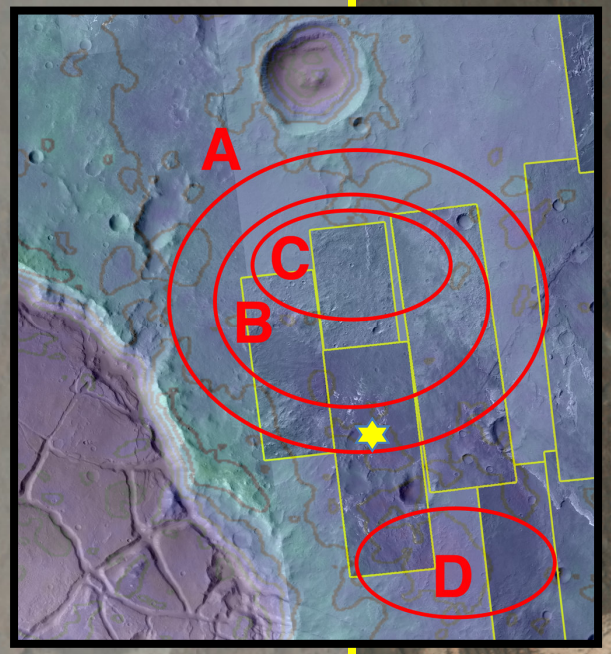
Light-toned deposits visible in SW of ellipse C

Light-toned deposits ~2.2 km south of ellipse C



Goal is to end up with rover here!!

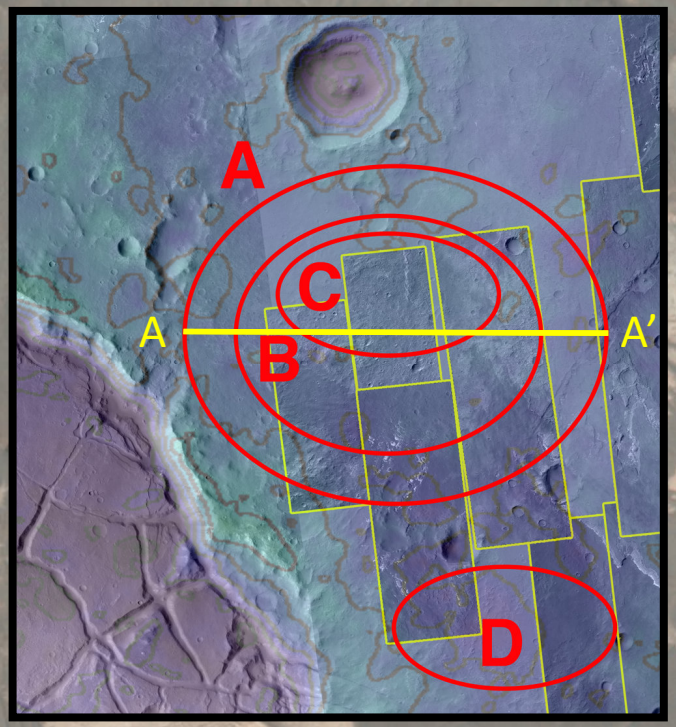
(southern portion of ellipse A)

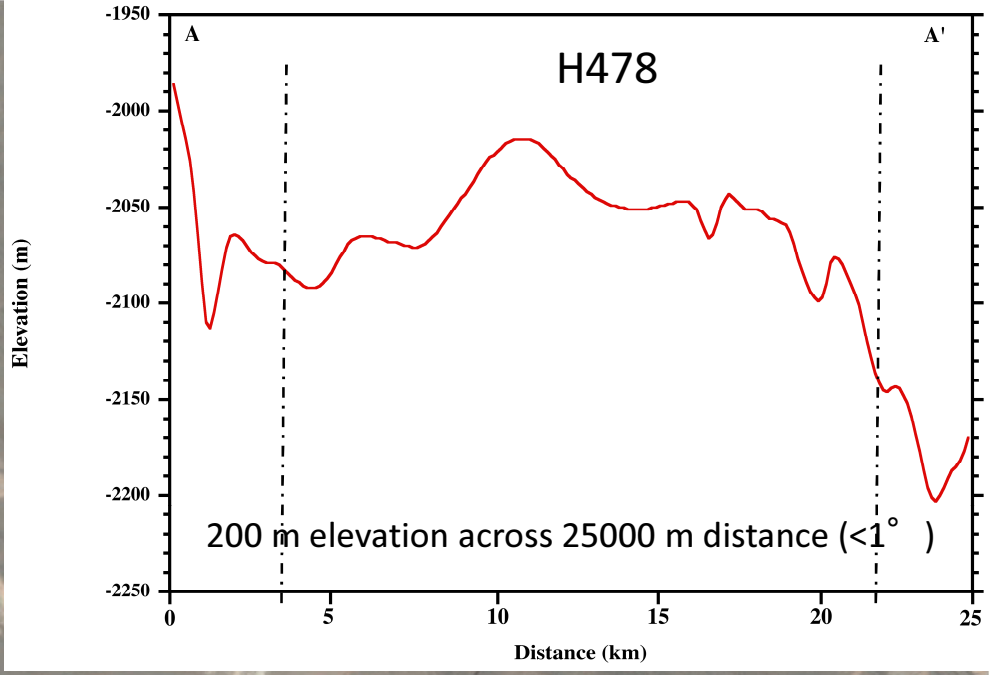


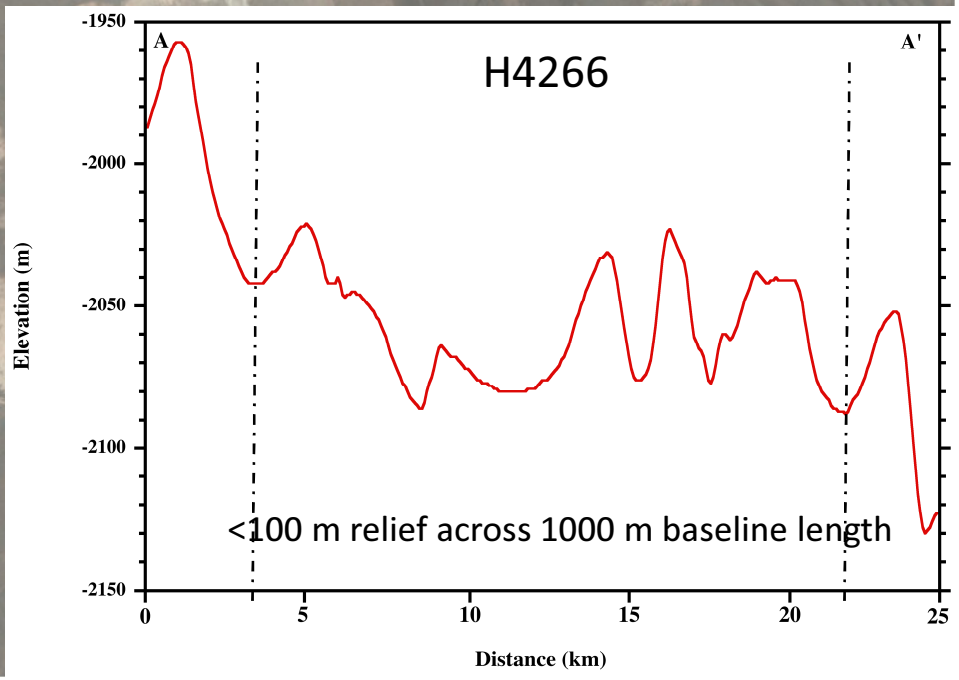
80 m

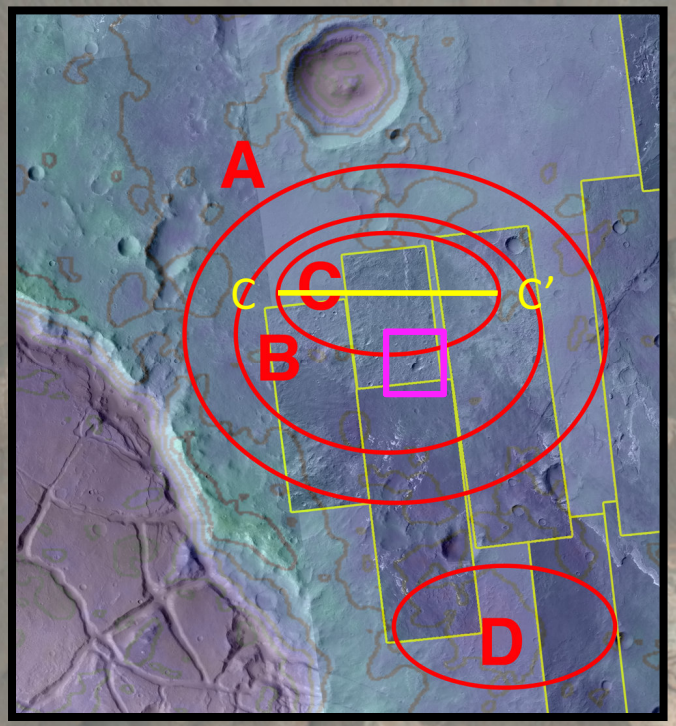
HRSC Topography

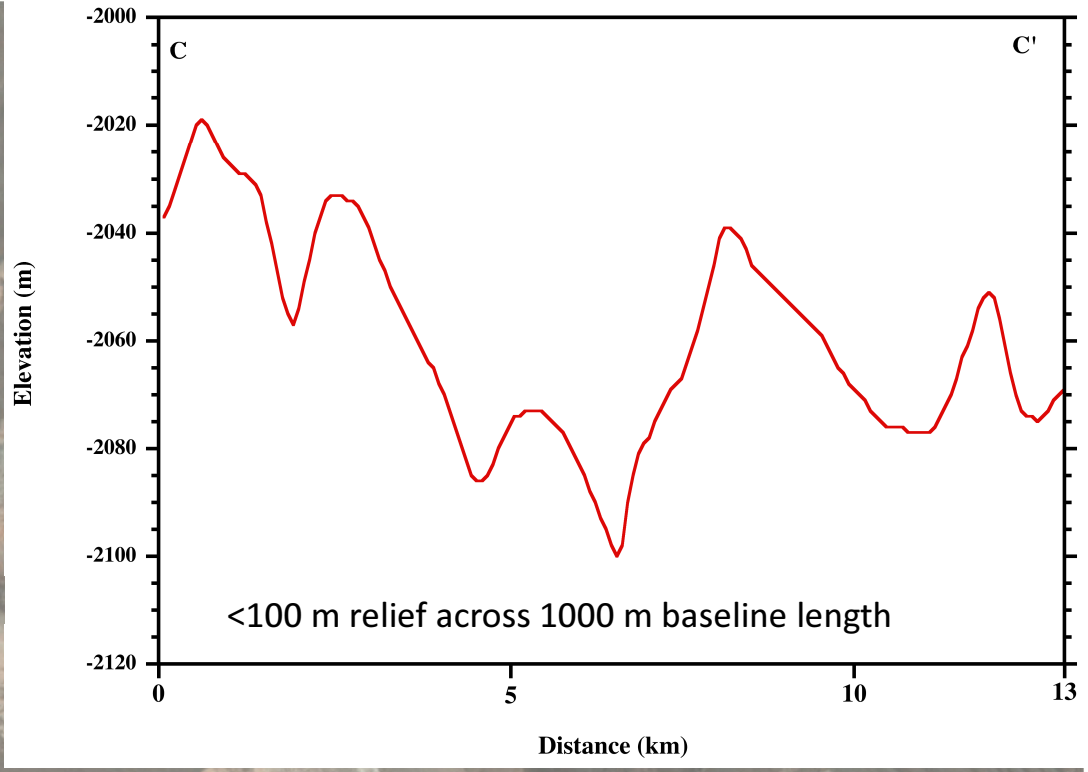
H4266 DTM resolution 75 m/pixel
H478 DTM resolution 125 m/pixel

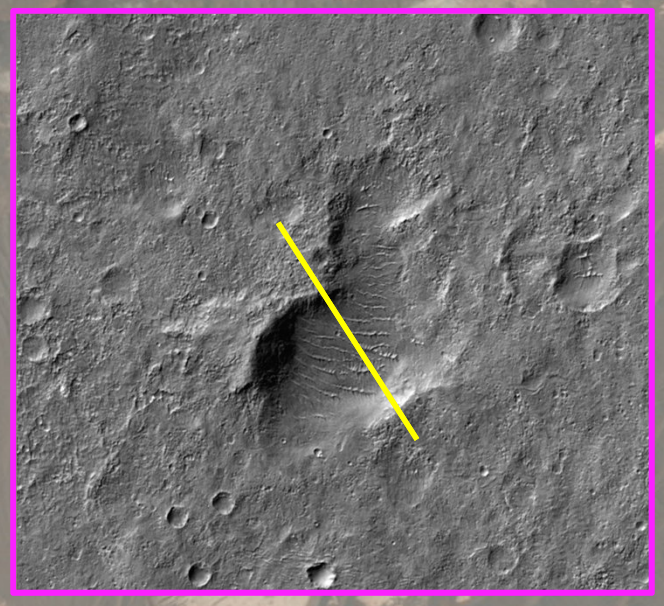


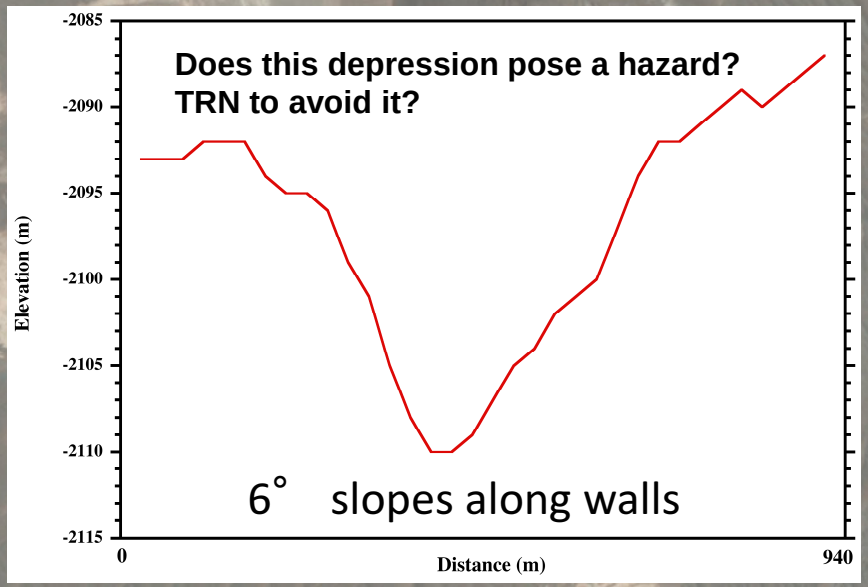





A
B
C
C
C'
D

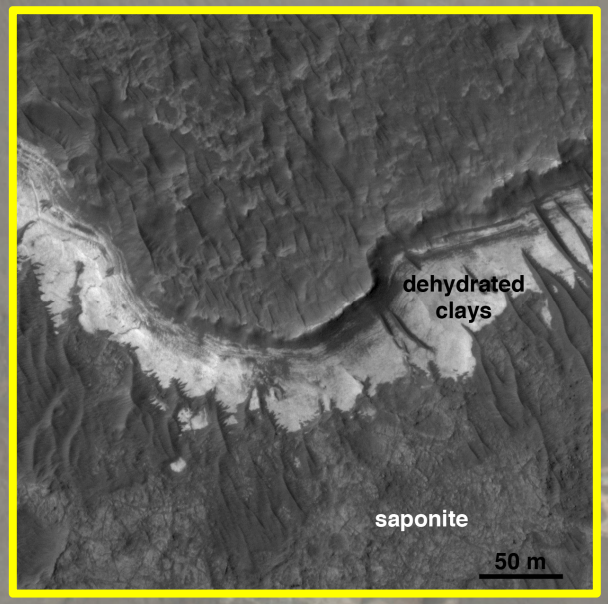

C
C'
Elevation (m)
-2000
-2020
-2040
-2060
-2080
-2100
-2120
0
5
10
13
Distance (km)
<100 m relief across 1000 m baseline length



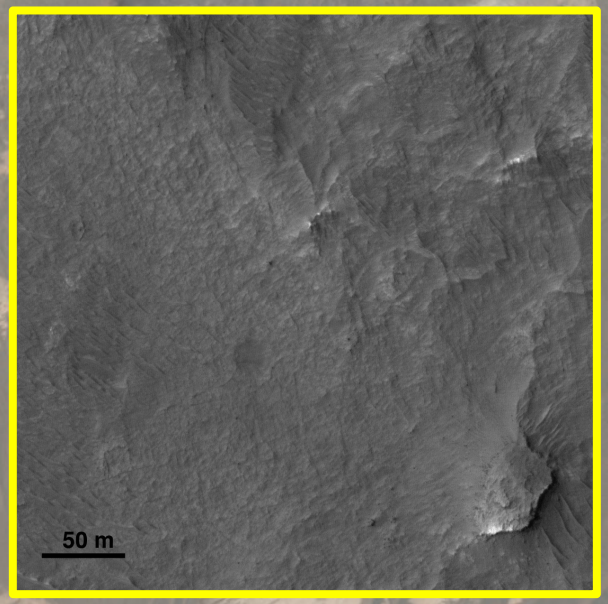

Does this depression pose a hazard?
TRN to avoid it?
Elevation (m)
-2085
-2090
-2095
-2100
-2105
-2110
-2115
0
940
Distance (m)
6° slopes along walls

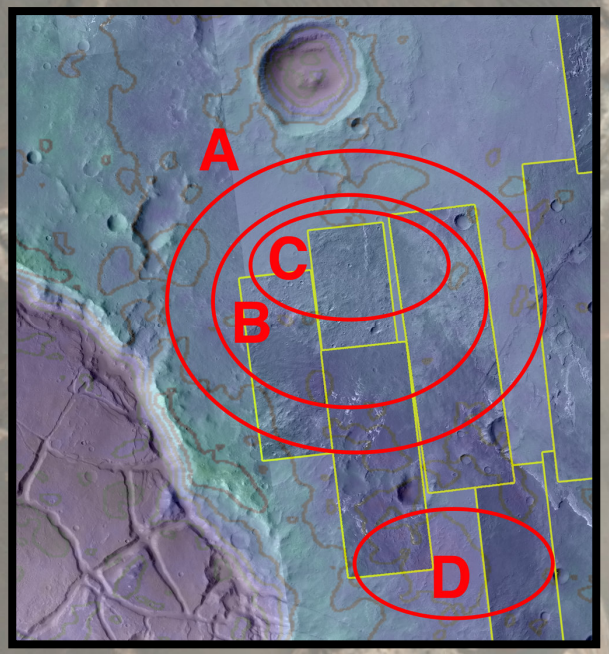
Ellipse D

Western ellipse terrain

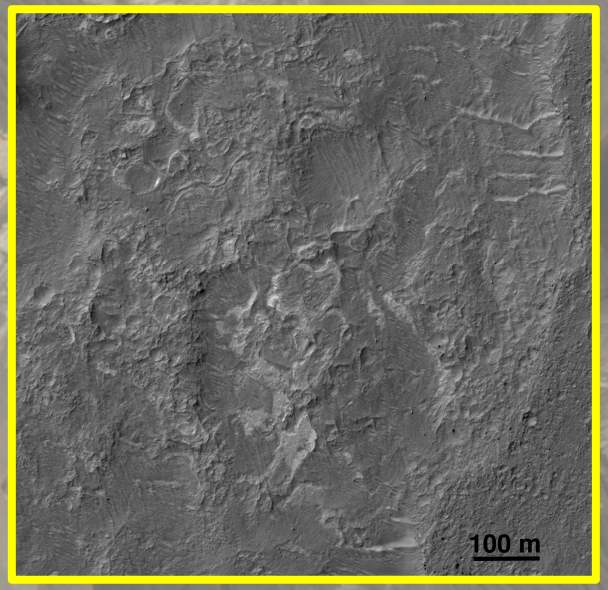


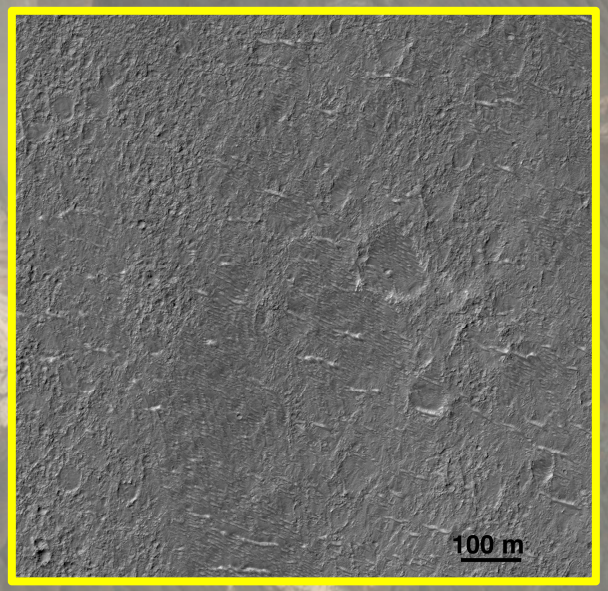
Center ellipse terrain





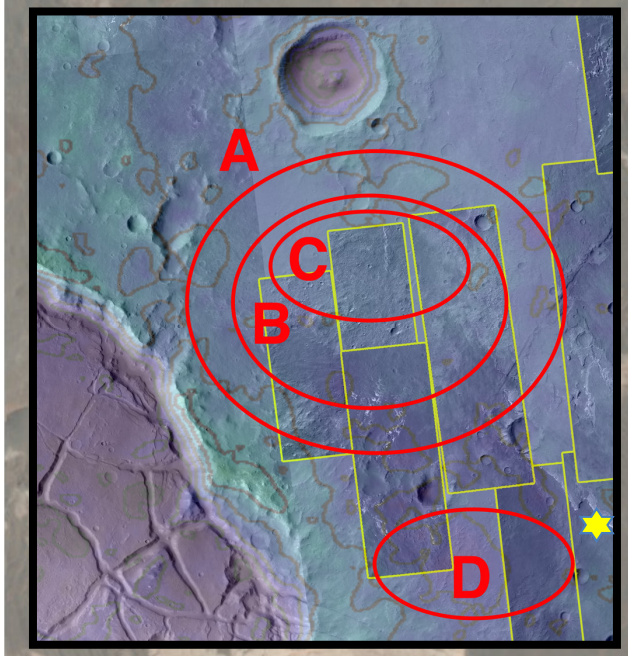
Eastern ellipse terrain

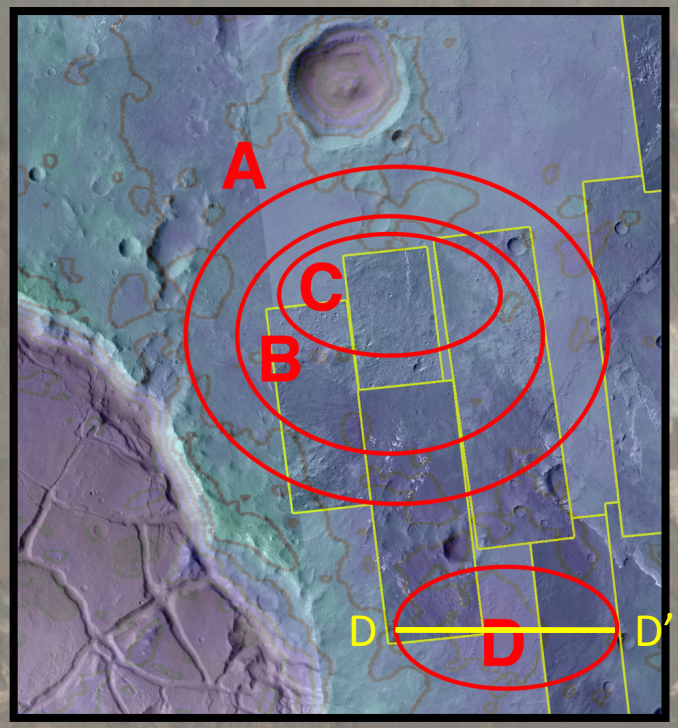


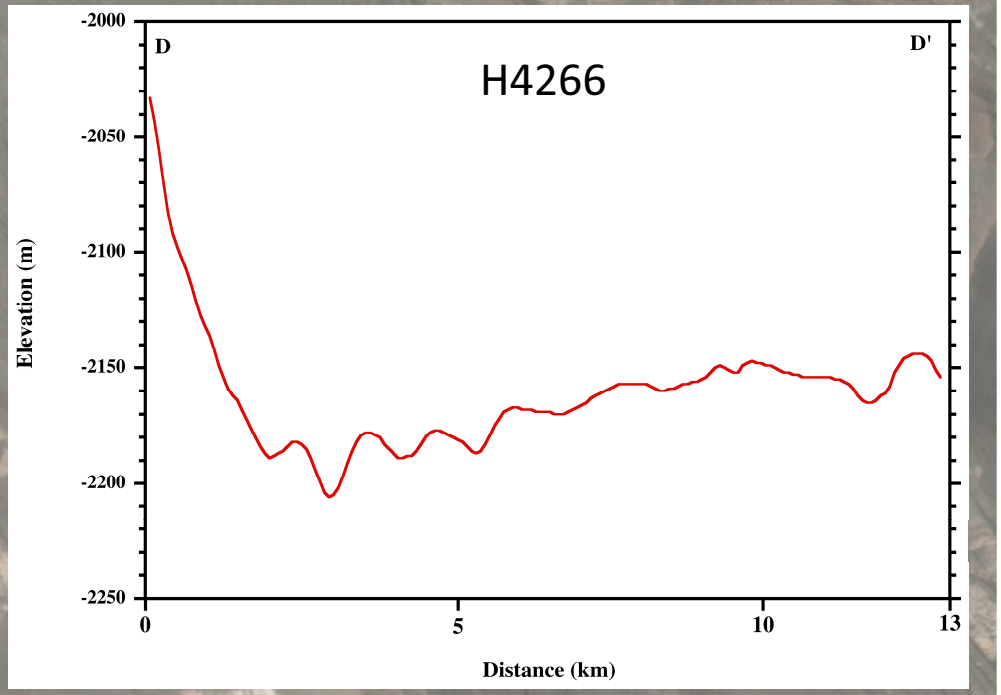


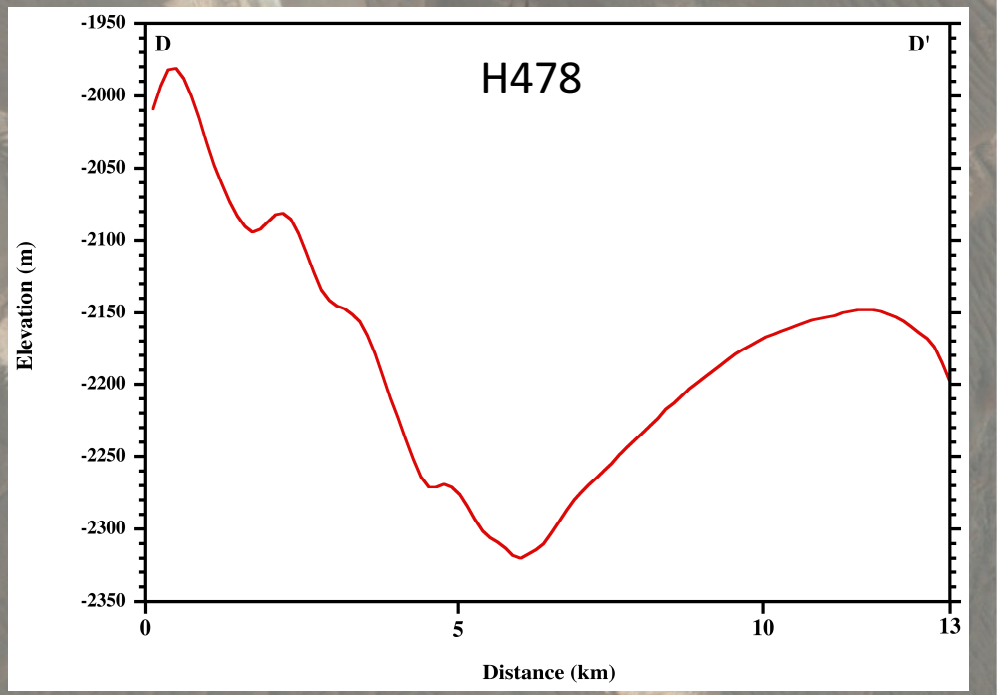
Goal is to end up with rover here!!

(~3 km northeast of ellipse D)

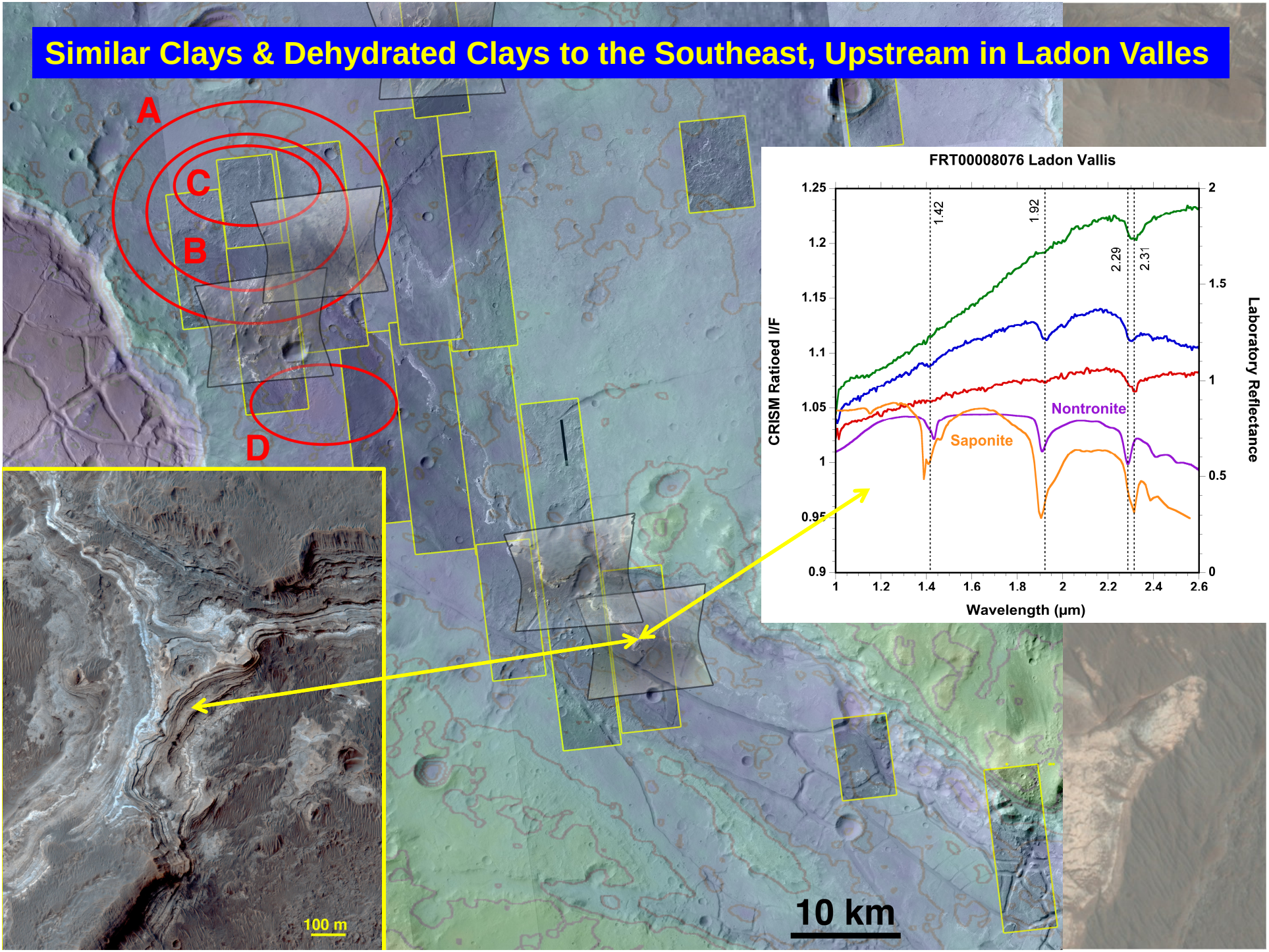



A
B
C
D
D
D'

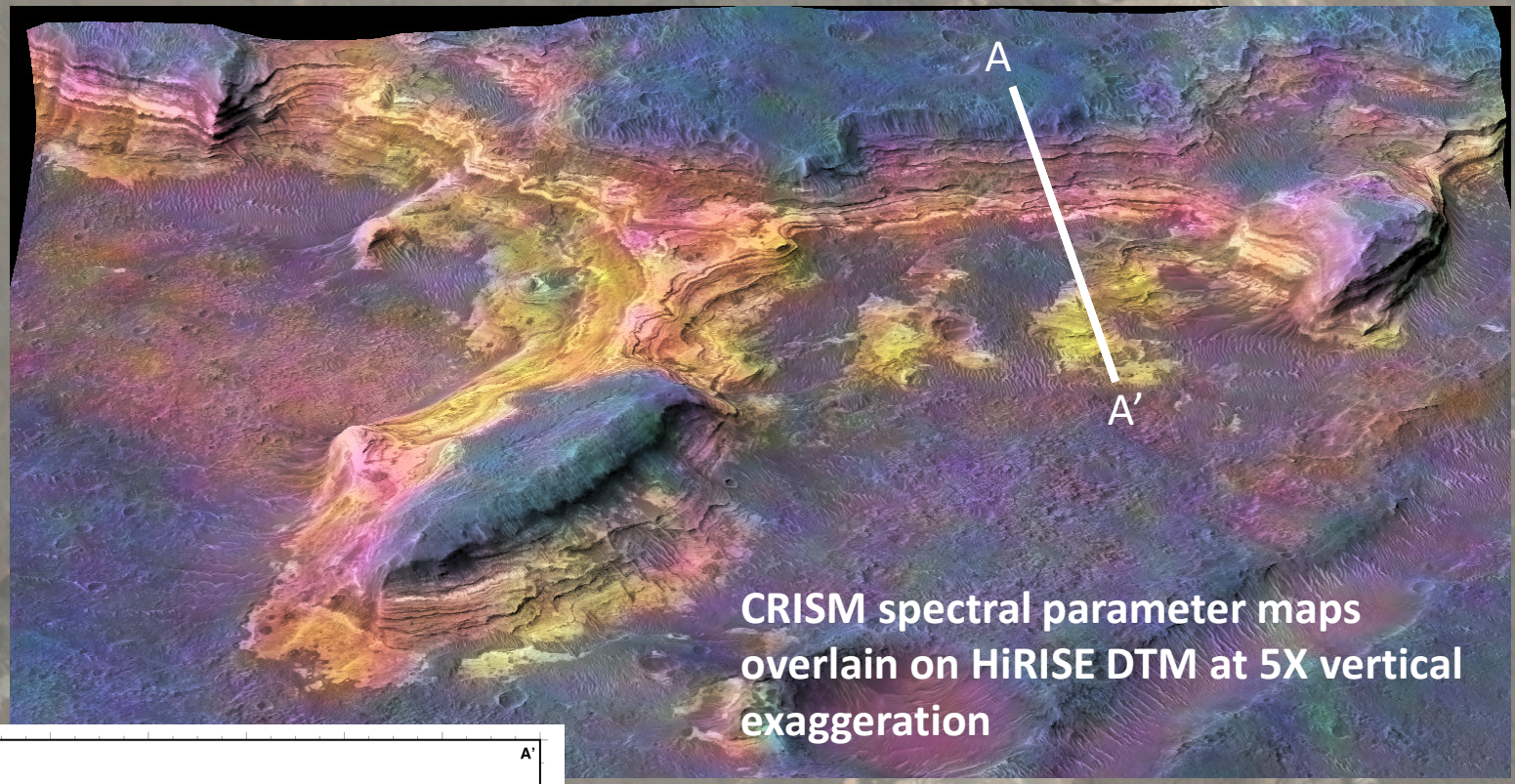

H4266
D
D'
Elevation (m)
-2000
-2050
-2100
-2150
-2200
-2250
0
5
10
13
Distance (km)


H478
D
D'
Elevation (m)
-1950
-2000
-2050
-2100
-2150
-2200
-2250
-2300
-2350
0
5
10
13
Distance (km)

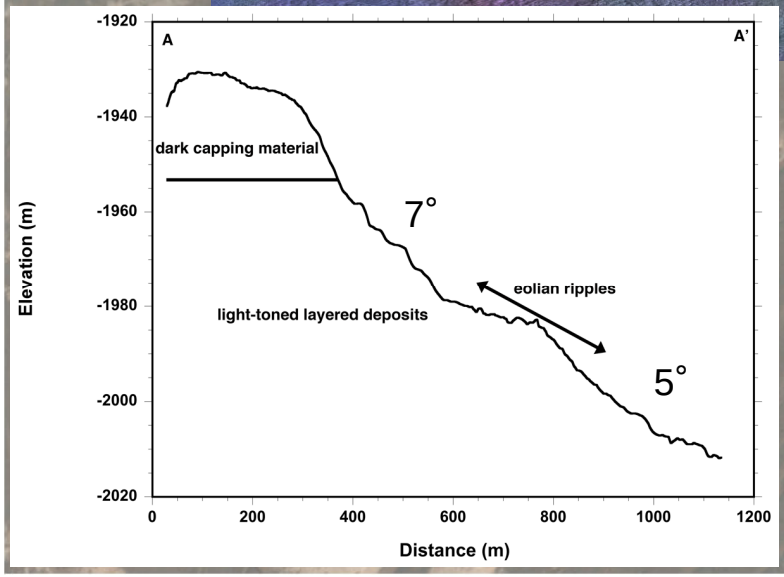
Similar Clays & Dehydrated Clays to the Southeast, Upstream in Ladon Valles



HiRISE DTM covers similar layered deposits to the southeast



CRISM spectral parameter maps overlain on HiRISE DTM at 5X vertical exaggeration



Topographic profile AA’ shows a 65 m thick sequence of exposed layered beds, with most beds only a few meters thick.

The beds appear horizontal as they can be traced across the same elevation for several kms. Bedding slopes derived from Orion software are 1-4° , consistent with deposition in a lacustrine setting.

Engineering Constraints

Parameter	Criteria	Compliance
Elevation	Below 0.5 km	Yes
Latitude	Within ±30° of equator	Yes
Slope	<20° over 2-10 km	Yes
	<25° over 2-5 m	HiRISE DTM needed to verify
Relief	<100 m over 1-1000 m	Yes
Rock Abundance	Probability of rock 0.55 m tall in area of 4 m^2 is <0.5%	HiRISE DTM needed to verify
Thermal Inertia	>100 $Jm^{-2}s^{-0.5}K^{-1}$	Yes
Albedo	<0.25	Yes

- **Range Trigger would allow landing in ellipses B,C,D to avoid possible hazards in Ellipse A**
- **Terrain Relative Navigation would be important for ellipses where there are small craters and relief that could pose hazards to landing (A,B)**

Geological Criteria

Presence of subaqueous sediments or hydrothermal sediments	Yes, layered sediments formed in outflow channels and/or Ladon basin
Presence of minerals indicative of aqueous phases	Yes, Fe/Mg-smectites and dehydrated clays
Noachian/Early Hesperian age	Yes, Ladon basin formed in Noachian, Ladon Valles formed in late Noachian/early Hesperian, layered sediments Hesperian in age [*Ross and Grant,* 2012]
Access to unaltered igneous rocks as float	HiRISE images show numerous boulders consistent with igneous rocks, cannot confirm they are unaltered
Not a Special Region	Yes
Morphological criteria for standing bodies of water and/or fluvial activity	Yes, Ladon Valles formed from outflow channels; Layered sediments have shallow dips, consistent with lacustrine deposition
Assemblages of secondary minerals of any age	Yes, clays and dehydrated clays
Presence of former water ice, glacial activity, or its deposits	Unknown
Igneous rocks of Noachian age	Ladon basin formation likely exposed these and Ladon Valles likely eroded through Noachian igneous rocks, but unknown if they occur within landing ellipses
Volcanic unit of Hesperian or Amazonian age	Unknown
Probability of samples of opportunity	Yes, Terminus of Ladon Valles could be full of numerous samples eroded and transported from upstream Crater just north of ellipses A-C brought up rocks from within Ladon basin that are within ejecta blanket inside ellipses
Potential for resources for future human mission	Unknown

Scientific Rationale for Ladon Valles

- Diversity of rock types transported through Ladon Valles and deposited within landing ellipse
- Sampling of older Noachian rocks exposed by Ladon basin formation and ~8 km crater north of ellipses A-C
- Sampling of numerous different Hesperian age sediments likely produced in lacustrine setting
- Fe/Mg-smectites and possible dehydrated clays at the landing site that record a wide range of fluvial, lacustrine, and possibly hydrothermal processes
- Igneous rocks likely within basin (think Gusev crater only much bigger)